AMRAD Newsletter

AMATEUR RADIO RESEARCH AND DEVELOPMENT CORPORATION

P.O. Drawer 6148 McLean, VA. USA 22106-6148 Vol. XVII - No.2

Calendar

Meetings are normally held on the first Monday of each month at the Red Cross Building in Merrifield Va.

Monday	Apr 2	Meeting
Sat	Apr 7	Cherry Blossom Parade
Sat	Apr 21	Massanutten Mountain Massacre (Old Dominion 50-mile Run)
Monday	May 7	Meeting
Sat-Sun	May 19-20	MS 150K Bike-a-thon
Monday	Jun 4	Meeting
Sat-Sun	Jun 9-10	Old Dominion 100-mile Ride&Run
Monday	Jul 2	Meeting
Monday	Aug 6	Meeting

AMRAD publishes six Newsletter issues a year (on the first weekend of each odd-numbered month). Authors are encouraged to submit copy to the Editor by the first weekend of even months for the next Newsletter. The originals of figures, pictures, or graphics should be directed to the Publisher (Bill Pala) with a copy to the Editor (Deborah Borden).

Presentations at the January 1990 AMRAD Meeting

A Synopsis

by Dick Barth, W3HWN

The January meeting was held on the 15th, the planned meeting on the 8th having been cancelled because of the weather. It began with a discussion by AMRAD president Andre Kesteloot, N4ICK, of possible future meeting sites. Future use of the Merrifield Red Cross building appears uncertain now that it has been taken over by the DC Red Cross. Various options were discussed, and Andre agreed to investigate the best-liked options.

Since a new meeting site may be selected soon, and the meeting date may also change to something other than the first Monday, members should check the AMRAD BBS, the HEX BBS, the AMRAD repeater, or one of the club officers before driving to the Red Cross building again.

It was announced that the speaker at the February meeting will be Dr. Bernhard Keiser, WD4O, who will cover the subject of radio propagation. Bernie is a consulting engineer and a regular lecturer on telecommunications technology at George Washington University and elsewhere.

The first speaker of the evening was Maitland Bottoms, who dealt with digital signal standards for compact disk (CD) machines. He wanted to know what the output of his CD player was so he could wire it up to his DSP board without going through A/D converters. He found that there is a semi-standard, used by Sony and Philips machines, called the Sony-Philips Digital Interface (SPDIF). It derives from the Audio Engineering Society/European Broadcasting Union (AES/EBU) standard. The original standard called for one sample of 32 bits per channel, or 64 bits per sample for stereo. The samples travel at 48 Kbps. Maitland's CD player puts out about one volt which is par for the SPDIF. The AES standard is three volts. The entire specification is available (and Maitland has ordered it) for fifteen dollars a copy.

His next project will involve Digital Audio Tape (DAT), the system which the audio industry has turned into a legal battleground in its disagreements over copy protection. It appears that the current standards would allow the taping of CDs, but not the duplication of tapes.

Hal Feinstein next spoke on signature analysis, the use of inadvertent modulation to identify particular transmitters. He became interested in this topic as a result of research for a book he is writing on the history of the FCC's Radio Intelligence Division. This group of World War II spy chasers had used an early form of signature analysis in identifying and locating clandestine transmitters. It gave them the ability to tell one transmitter from another, and thus to determine how many transmitters were operating in an area.

In one case, it led the allies to conclude that there were three transmitters, and three different spy rings, operating out of Buenos Aires. Further investigation proved this correct. One professional ring had been set up to collect shipping information and radio it to waiting U-boats. A second had infiltrated banking and political circles and was providing intelligence in this field. These two proved rather hard to track down. The third ring turned out to be a group of amateurs who were nailed with relatively little difficulty.

Identifying these spies was easier than catching them. The U.S. could find them but arrests in a foreign country had to be made by local officials. Argentine police were sympathetic to the German cause, and requests for an arrest often led to the intended arrestees quietly disappearing and suddenly coming on the air from a new location.

Hal heard from a friend at the FCC that a ham in Washington state had developed a crude DFT system to identify kerchunkers on a local repeater. A senior engineer at the FCC picked up on the idea, and had some equipment of this type developed for Commission use. It has been used

in several cases to identify jammers and other illegal transmissions.

Hal and Terry Fox conducted several experiments in which a digital storage scope was used to capture the turn-on transients of two meter handi-talkies. The displays were plotted and shown at the meeting. There was a clear family resemblance in the transients displayed by equipments of the same type, and it was easy to distinguish between equipments of different manufacture. It was easy to see how specific transmitters could be identified with greater effort and better equipment.

The process of comparing two signatures involves, in the language of the trade, "feature extraction" or the determination of those features of the display which characterize a particular emitter. The determination of the degree to which a particular signal matches a "feature" is termed a "feature metric". This entire process is called syntactic pattern analysis. The analysis and comparison of such signals was compared to language analysis, as by a compiler.

Jeff Brennan next displayed a fifteen watt MOSFET two meter power amplifier he has spent the last couple of years building. It is intended for use in the AMRAD repeater, provides a 1 dB noise figure and is 70% efficient. Amplifiers of this design are not commercially available.

The MOSFET costs about twelve dollars; parts for the entire amplifier would run about fifty.

Jeff hopes that the new amplifier, which has a considerably lower noise figure than the bipolar amplifier it replaces, will allow a significant improvement in weak signal reception and in reliability.

The MRF-series Motorola transistor used will operate with power supplies up to 36 volts and provides 13 dB of gain at 24 volts. At 13.6 volts (where Jeff plans to run it) the gain is ten dB.

Presentations at the February 1990 AMRAD Meeting

A Synopsis

by Dick Barth, W3HWN

The speaker at the February meeting was Dr. Bernhard Keiser, WD4O. Bernie has been our guest speaker at a number of previous meetings. He was last here at the October 1988 meeting, when he covered the variety of amateur spectrum uses with emphasis on the 420 MHz band. His topic tonight was radio propagation, a topic which he covers regularly in his professional lectures.

Certain principles, such as reflection, refraction and diffraction, affect radio wave propagation at all frequencies. Others, such as absorption, occur primarily at higher frequencies.

For a given transmitting apparatus, the total amount of energy radiated is constant, and is equal to the transmitter output minus any losses in the radiating device. If the radiated energy is emitted from a theoretical point source - if it radiates equally in all directions - the amount of energy passing through a sphere centered at the point source is constant but the energy passing through a given area of the sphere varies as the ratio of that area to the total surface area of the sphere. Thus if P watts is being radiated, then a surface area A at a distance of D meters from the source sees a power density of

P*A / (4 * PI * D**2) watts per meter squared,

where PI is 3.14157....

The energy transmitted in a desired direction can be increased by using a reflector to redirect energy from the "wrong" directions to the "right" one, much as one uses a reflector behind a flashlight bulb to focus the light where it's needed. If this is done, all the radiation will ideally be in some solid angle of size OMEGA steradians around the favored direction. Hence, one arrives at a power density within angle OMEGA of

P*A / (OMEGA * D**2) watts per meter squared

and the gain of the antenna arrangement is 4 * PI / OMEGA.

It is clear then that the gain of an antenna is obtained by reducing its beamwidth. Note that the operating frequency does not enter into the equation. Why then do path loss equations contain frequency terms? The simplified answer is that the "effective" as opposed to the "physical" aperture of an antenna is given in terms of wavelength, hence frequency must be factored in.

A "link budget" is used in working up power requirements for a radio link which includes consideration of transmit power, antenna gain, path length, and receiving antenna aperture. It yields as the received power:

Pr = Pt * Gt * Gt * (LAMBDA**2)/(4*PI*D)

where Pr is received power, watts
Pt is transmitter power
Gt is transmit antenna gain ratio
Gr is receiver antenna gain
LAMBDA is the wavelength
D is path length in the same units as LAMBDA

The final term in the above - (LAMBDA**2)/(4*PI*D) - is termed the "spreading loss" of "free space path loss" and reflects energy dispersion over the propagation path.

A radio wave includes both an electric vector and a magnetic vector. The electric vector (a.k.a. "E-field") is measured in volts per meter while the magnetic ("H") vector is in amperes per meter. Their ratio (volts/amps) is the characteristic impedance of the propagation medium. Their product (volt-amps per meter squared) is the power density. These vectors are perpendicular both to each other and to the direction of propagation. In radio usage, the "polarization" of a wave is defined as the direction of its electric vector. Thus a horizontal dipole emits a horizontally polarized signal, since the E-field (which runs from one end of the dipole to the other) lies in the same direction as the antenna itself. A "circularly polarized" antenna is one in which both the E and H vectors rotate one revolution per

second for each Hertz of carrier frequency. Hence a circularly polarized 5 MHz signal spins five million revolutions per second. It is achieved by separating two sets of antenna elements by one quarter wave length, either physically or by means of phasing lines.

Line of sight or LOS propagation is commonly employed at microwave frequencies. Absorption, refraction and diffraction have a strong effect on propagation here. Absorption includes the attenuation of the signal by fog, precipitation, oxygen, or other contents of the atmosphere. Signal absorption can also happen to ground waves by passage through trees or over lossy ground. Absorption is most noticeable at EHF and up, and over extremely long paths. Absorption by rain occurs most strongly when the drops are multiples of a half wave at the operating frequency, which causes back scatter of the signal and attendant losses in the forward direction.

Refraction is the bending of the signal caused by changes in the dielectric constant of the propagation medium. Diffraction, on the other hand, is bending caused by the presence of an obstacle near the path. Diffraction around an obstacle results in rather continuous spreading of the signal on the other side, with the signal level decreasing rapidly as the angle of bending increases and as the frequency goes up.

Which brings us to the discussion of "Fresnel zones". A Fresnel zone is the locus of points having a constant distance from one antenna to another, and in particular, having a distance which differs from a straight line by an exact multiple of one half wavelength. Thus a signal reflected from any point on the "first Fresnel zone" will travel exactly one half wavelength further than the direct signal. A reflection from any odd-numbered Fresnel zone will arrive out of phase, while one from an even Fresnel zone will tend to reinforce the direct signal. Reinforcement improves the received signal strength by 6dB, while out-of-phase signals can theoretically cause a complete outage.

The shape of the Fresnel zone is formed by rotating around its major axis an ellipse having its foci at the two antennas. The axis dimensions are determined as above, with the major axis depending primarily on path length and the minor axis becoming smaller as the frequency goes up.

Reflection from the ground is often not significant above 2 or 3 GHz because the beam is many wavelengths above the ground. At lower frequencies this may not be the case. Factors which can improve system performance by reducing flutter fading are narrow beamwidths (which tend to reduce the signal incident on the reflecting point) and horizontal polarization, which reduces the amount reflected. The reflection coefficient (defined as the ratio of the reflected vs. the incident signal) is higher for smooth surfaces, so microwave designers make sure that reflection points don't occur over water, ice fields, etc.

Moisture in the air causes a change in the dielectric constant, of the air, since moisture drops have a dielectric constant of about 2.2 while that of dry air is 1.0. Usually this constant decreases with altitude as the air density decreases. There is a temperature decrease with altitude of about 6.5 degrees C per km. Refraction is usually described by a "K factor" which compares the radius of curvature of the signal with the radius of the earth. The "normal" value of K is 4/3, which causes the signal to bend less than the curvature of the earth. There is a slight outward bulge of the ray under these circumstances. When at times K is infinity "ducting" occurs, "the bands are open" and signals propagate wildly in all directions. When K becomes less than one - a condition called "subrefraction" - signals bend away from the earth, propagation becomes very problematic, and poorly designed systems take a vacation until conditions improve.

The distance of the radio horizon depends both on antenna height and the index of refraction.

Tropospheric scatter (troposcatter) can be worked with amateur power levels and antennas. It involves scattering of the incident signal by atmospheric particles; both forward and backscatter can occur. This mode was once used extensively in commercial and military use, but this has been largely supplanted by satellite and cable systems. The troposcatter mechanism exists at all times but is limited in terms of the bandwidth that can be supported because of group delay spread. There is also some rather fast fading which can be reduced by diversity techniques. Frequency and space diversity in multiple orders have been employed. Power fading follows the Rayleigh curves which result from multiple signals whose voltage is Gaussian distributed.

In tropo there is a limit on antenna gain caused by the fact that an increase in gain causes a reduction in beamwidth and hence in the size of the illuminated volume. As fewer scatterers are hit by the beam, the scattered signal becomes weaker. This reduction in received signal with increases antenna gain is referred to as "antenna-to-medium coupling loss" and is not significant with typical amateur equipment.

Fading at HF can be improved by various techniques, with adaptive echo cancellation seeming a likely candidate. The problem is to prevent echo from reaching the user. The canceller works on the principle of a tapped delay line, with the taps being dynamically adjusted depending on what the system is doing at any given moment.

The President's Ramblings:

by André Kesteloot N4ICK

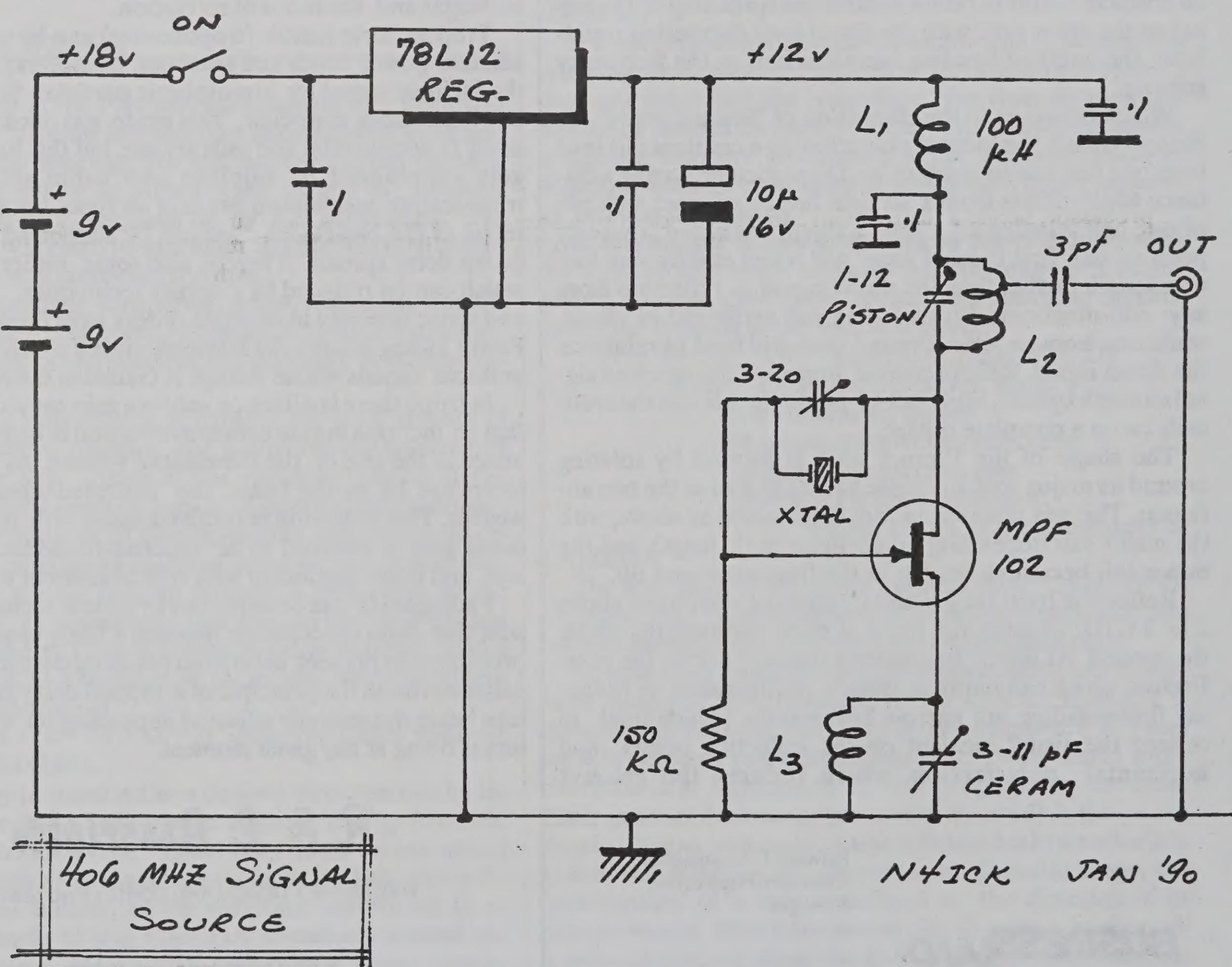
A UHF Signal Source.

As reported elsewhere, several AMRAD members have been involved for the past year in a project for NASA. The problem included DFing on the latest Emergency Locator Transmitters (ELT) which now transmit on 406.025Mhz. Before DFing can take place, receivers must be tested and tuned. Since the satellites which listen to transmissions on this frequency are already deployed, it is important to have an accurate, stable signal-source which radiates as little power as possible.

I built in a small diecast box the signal-source shown on the figure. A crystal cut for 45.113889 MHz is placed in the feedback path from Drain to Gate in a FET oscillator. In the Source path is inserted a LC circuit tuned to 45 MHz, while another circuit, tuned to 406 MHz is placed in the Drain lead.

The trimmer ceramic capacitor in the Source circuit is first adjusted until oscillations take place at 45 MHz. Seen on a spectrum-analyzer, the output of the signal source will show spurs at 45.113889 and all harmonics of that frequency (at least till 600 MHz). After having made the circuit to oscillate, the capacitor in parallel with the crystal is adjusted to obtain exactly 45.113889 MHz (or 1/9th of 406.025MHz.) Finally, the piston capacitor in the Drain lead is adjusted to obtain maximum output at 406.025 MHz (i.e. to favor the 406 spur versus the others.) A quarter-wave whip cut for 406 MHz is then plugged into the output receptacle.

The coil in the source lead is about 0.47uH with an adjustable core. I used a TOKO BTKXNS-10482 coil, while the output coil is made out of 1 and 3/4 turns of 16 AWG tinned copper, wound on a 1/2 inch drill bit, then spread out to 1/2" length. The tap is at 1/2 turn from the cold side. A 78L12 regulator is used to enhance the stability of the oscillator.



Presentations at the March 1990 AMRAD Meeting

A Synopsis

by Dick Barth, W3HWN

The March fifth meeting featured a presentation by Glenn Baumgartner, KA0ESA, on his efforts over the past year to develop a homing receiver for 406 MHz SARSAT EPIRBS. SARSAT (Search And Rescue Satellite Aided Tracking) is a joint project among many nations to increase the effectiveness of rescue efforts on behalf of downed aircraft, stricken ships and the like. It involves COSPAS spacecraft from the USSR and SARSAT satellites from the US. SARSAT transponders are actually carried aboard two types of U.S. meteorological satellites, the polar orbiting TIROS/NOAA series and the geostationary GOES series, both operated by the National Oceanic and Atmospheric Administration (NOAA). The transmitters carried aboard many ships and aircraft to send out distress signals are called EPIRBs (Emergency Position Indicating Radio Beacons) or ELTs (Emergency Locator Transmitters).

There are three frequencies used by SARSAT, two at VHF (121.5 and 243 MHz) and one at UHF (406.05 MHz). The VHF signals are relayed by the satellite acting as a "bent pipe". This requires that the satellite must be visible simultaneously to the distressed vessel and to the receiving site. In the UHF version, the satellite acts as a store-and-forward processor, hence a distress call can be picked up by a satellite and dumped to a receiving site on the other side of the world.

An aircraft ELT is triggered by the impact of a crash. A small weight inside the equipment strikes a switch handle when a blow of sufficient force is struck against the case. Or such is the theory; construction of these switches is often flimsy and they frequently do not function during a crash. There have been no strict specifications on EPIRBs until quite recently, and these have not yet been fully implemented. In the case of aircraft, failures to function can also be caused by the outside antenna breaking off during the crash, or ending up underneath the airplane. Output power of a VHF ELT varies between 50 and 250 milliwatts, while the UHF units run five watts.

ELTs were originally intended for ground tracking, and were meant to be picked up in search and rescue (SAR) vessels (aircraft and ships). The use of satellites to detect a distress call was developed by amateurs using OSCAR satellites. Governments picked up on the idea and expanded it.

Both VHF and UHF modes permit determination of a stationary ELT's approximate location when its signal is picked up by moving satellites. This is done by measuring the Doppler shift on the uplinks. This shift is upward as the spacecraft approaches the ELT, becomes zero when the satellite comes abreast of it, and goes downward as the bird recedes. With only a single sighting, there is uncertainty as to which side of the satellite track the ELT is on; a second satellite pass removes this. Additional passes reduce the margin of error.

The cheapness with which ELTs are built tends to make their emitted frequency unstable; this reduces the accuracy of position measurements. Uncertainties of thirty or forty miles are common. The newer generation of EPIRBS (the UHF variety) are required to have a stability of 5 KHz per five years, with short-term stability of one part in ten to the ninth. These produces position locations of under a mile on occasion with two or three miles being typical.

VHF EPIRBs transmit a continuous carrier amplitude modulated by a warble tone, which makes them easy to home on once rescue forces have arrived in the vicinity. The UHF models, on the other hand, transmit a 600 millisecond burst every fifty seconds. These signals are encoded with the identify of the vessel and other significant information, but their brevity makes it very difficult to home on them. NASA had been unable to develop a system for tracking these devices, and Dave Rogers of AMRAD offered to organize a team effort to come up with something.

Direction finding is difficult under the best of circumstances because of multipath effects. Reflected signals from buildings, rocks and other ground clutter can throw off direction readings by large amounts. The solution under these circumstances hinges on the fact that as long as the DFer can keep moving, a lot of bad direction readings will eventually average out to something near the right answer.

Several AMRAD members built variations of DF devices that would indicate whether the target was ahead, behind, or to the right or left. While all worked reasonably well on continuous signals, it was clear that they would not handle once-a-minute bursts. It was decided to try a Doppler approach. The military is fond to the time-difference-of-arrival approach, which has its advantages, but the computer needed to make it work takes these systems out of the $200 price class NASA was looking for in a DFing device.

Doppler direction finders, on the other hand, are simple and inexpensive to build. They use a rotatable platform holding four antennas. As the platform spins, one antenna is moving toward the target while that diametrically opposite is moving away at equal speed. The resultant Doppler shifts have a zero crossing when the two antennas are lined up with the target, and maximum magnitude when they are at right angles to it. Knowledge of the direction of rotation removes any ambiguity as to the direction of the target.

The demonstration prototype DFer was built around a kit sold by Dick Smith Electronics several years ago. The kit was eventually withdrawn from the market, possibly because it was difficult to make work. It was unstable with respect to temperature and voltage. Andre Kesteloot modified the PLL circuit so it would lock up readily on weak signals. Other mods were added as well, including a $12.95 paging receiver that serves as a front end.

(continued on page 7.)


DX Pedition Time
SUNSHINE TRAVEL
VISIT
TAHITI
Chuck
N4EZV

A TAB book is recommended reading for those with an interest in transmitter hunting. It lists for $17.95 and is titled "Transmitter Hunting - Radio Direction Finding Simplified" by Joseph D. Moell, K0OV and Thomas N. Curlee, WB6UZZ. It goes into a variety of low-cost DFing techniques as well as some professional systems used by the military.

AMRAD MEMBERSHIP APPLICATION/RENEWAL

Mail to: Membership, AMRAD, P.O. BOX 6148, McLean, Va. 22106-6148

ANNUAL DUES: Regular $15; 2nd in family at same address add $8; Canada and Mexico add $2; foreign surface add $2.30; foreign air mail add $8; currency is US dollars. A donation to the WD4IWG/R repeater fund is appreciated if you use the repeater. Please make checks payable to AMRAD.

Name______________________ Amateur Call__________ License Class________

Street Address____ App#________

City________________________ State/Prov__________ ZIP/PC__________

Country______________ Home Phone (___)_____-_____ Work Phone (___)_____-_____

Special Interest Groups: please indicate your interest.

__Deaf Communications __RTTY __Spread Spectrum __Packet Radio __Digital Signal Processing

Network: CompuServe ID:__________

__________ ID:__________

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AMRAD

The Amateur Radio Research and Development Corporation (AMRAD) is a worldwide club of several hundred amateur radio and computer experimenters. It is incorporated in Virginia and is recognized by the U.S. Internal Revenue Service as a tax-exempt scientific and educational organization.

AMRAD's Purpose

The purpose of AMRAD is to: develop skills and knowledge in radio and electronic technology; advocate design of experimental equipment and techniques; promote basic and applied research; organize technical forums and symposiums; collect and disseminate technical information; and provide experimental repeaters.

Meetings

Meetings are on the first Monday of each month at 7:30 P.M. at the Red Cross Building, Merrifield, VA. If the first Monday is a holiday, an alternate date will be announced in the newsletter. Except for the annual meeting in December, meetings are reserved for technical talks - not business.

WD4IWG Repeater

WD4IWG/R is an open repeater for FM voice and digital communications, especially for experimental modes. It is located in McLean, VA. It features an autopatch available to licensed members. Frequencies are: 147.81 MHz in and 147.21 MHz out. The repeater director is Jeff Brennan, WB4WLW.

Westlink Report

The Westlink report is aired every Sunday night at 8:00PM on the WD4IWG repeater.

WB4JFI-5 Digipeater

WB4JFI-5 is a 1200-baud AX.25 Level 2 digipeater operating on 145.01 MHz. It is located in northwest Washington DC at Wisconsin Ave. and River Rd. The digipeater is mounted at an elevation of 350 feet on the south leg of the WUSA/WJLA TV tower.

Data Address

Our CompuServe/Micronet number is [72345,1050].

AMRAD Computer Bulletin Board System

AMRAD CBBS, (703) 734-1387, is operated by Lawrence Kesteloot, N4NTL. The system accepts calls at 300, 1200 and 2400 baud. The data path settings are 8 data bits, 1 stop bits, and no parity.

HEX Bulletin Board System

Handicapped Education Exchange is operated by Dick Barth, W3HWN. HEX accepts TDD/300 baud at (301) 593-7033,and 300/1200 baud at (301) 593-7357. ASCII is 8N1

Affiliations

AMRAD is affiliated with the American Radio Relay League (ARRL), Foundation for Amateur Radio (FAR), Northern Virginia Radio Council (NOVARC) and the Mid-Atlantic Repeater Council (T-MARC).

AMRAD Newsletter

The AMRAD newsletter is mailed six times a year to members and other clubs on an exchange basis. Technical articles, product announcements, news items, and other copy relating to amateur radio and computing is welcome. Honorariums of one year free membership are given for original material accepted. Maximum of one year per year. Classified ads are free to members. Commercial ad inquires are invited. The editor reserves the right to reject or edit any portions of the copy. Items should be mailed to Editor, AMRAD Newsletter, P.O. Drawer 6148, McLean, VA 22106. Full permission for reprinting or quoting items is granted provided that credit is given to both the author and the newsletter. Membership in AMRAD is $15 annually ($8 for second member of same family). Mailing to U.S. and possessions is by 3rd Class bulk mail. Canadian and Mexican addresses add $2 for postage. Overseas readers add $8 for air mail or $2.30 for surface.

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Jeffrey Brennan	WB4WLW	Alternate Director	(703) 698-7924
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